Cruise Report C3O 2012-09

Pacific Region Vessel CCGS *Sir Wilfrid Laurier*

DATE: **FROM:** 4 July 2012 **TO:** 22 July 2011

SCIENCE CRUISE NUMBER: 2012-09 **SHIP'S PATROL NUMBER:**

CHIEF SCIENTIST: Svein Vagle

INTRODUCTION/PROGRAM BACKGROUND:

The Canada Three Oceans project "C3O" was part of Canada's contribution and now a continuation of the International Polar Year research effort. The focus of this collaboration between government institutes and national as well as international universities is to study impacts of climate variability on the sub-arctic and Arctic water circulation and on the associated ecosystems. This research cruise is also part of the Distributed Biological Observatory (DBO) effort, which is an international effort to make repeat oceanographic observations at chosen stations in the Southern Chukchi Sea and in Barrow Canyon. This year we were also fortunate to be able to collaborate with JAMSTEC to help with the deployment of four biogeochemical moorings deployed in Southern Chukchi Sea and in Barrow Canyon, along DBO lines. This year the transect across the NE Pacific was along a more southern route to allow for deployment of Argo floats in areas lacking such floats.

CRUISE OBJECTIVES:

During this cruise aboard the CCGS Sir Wilfrid Laurier data were collected on the physical, biological and geochemical properties of ocean waters across the North Pacific Ocean, and the shelf regions of the Bering and Chukchi Seas. Data were also collected on the benthic ecosystems in the Bering & Chukchi Seas.

The shipboard data collection included physical, biological, geochemical and benthic sampling:

- Profiles of water temperature and salinity were obtained with CTD, and an underway CTD system.
- Additional sensors on the CTD profiler collected in situ data on phyto-plankton concentrations (fluorometer), optical clarity (transmissometer), dissolved oxygen and photoactive radiation (PAR).
- A rosette sampler was used with the CTD to obtain water samples from discrete depths for a broad suite of biological and geochemical parameters, some for onboard analysis, others to be stored for later analysis in shore-based laboratories.
- Benthic sampling using Van Veen grabs.
- Both bio-acoustic backscatter data and depth-varying current information were collected using a RDI Longranger 150 kHz Acoustic Doppler Current Profiler (ADCP) deployed over the port side of the ship at most of the science stations.
- Zooplankton samples were obtained in vertical hauls by Bongo-nets lowered to 100 m or from bottom depth minus 10 m in waters shallower than 110 m.
- Continuous underway sampling of near-surface seawater temperature, salinity, fluorescence, oxygen and nitrogen.
- Samples were collected for analysis of chlorophyll.

- Onboard laboratory primary productivity experiments were performed in incubators located on the helicopter deck.
- Bird and marine mammal observations.
- Drift-bottle deployments.
- Deployment of 4 biogeochemical moorings along Distributed Biological Observatory (DBO) lines in Southern Chukchi Sea and in Barrow Canyon.
- Deployment of 21 Argo floats.
- Deployment of 4 Surface velocity profilers (SVP)

DAYS ALLOCATED: 18 **DAYS OF OPERATION:** 18

SCIENTIFIC PERSONNEL: In Victoria (VIC), 10 scientists embarked and stayed onboard until Barrow Alaska where 7 were flown off the ship by helicopter to Barrow on July 21. The bird observer (Mike Bentley) stayed onboard until crew change in Kugluktuk and the two JAMSTEC personnel stayed onboard the ship until July 24th when they disembarked in Barrow.

Name	Tasks	Affiliation	from	To
Svein Vagle	Chief Scientist / Bio-acoustics/Underway surface water analysis/UCTD/CTD	DFO-IOS	VIC	Bar
Amber Messmer	Zoo-plankton/CTD / sampling	UVIC	VIC	Bar
Rhiannon Pretty	Phyto-plankton	UVIC	VIC	Bar
Mike Bentley	Bird Observer	CWS	VIC	Kug
Jackie Detering	Underway surface water analysis/UCTD/CTD	DFO-PBS	VIC	Bar
Monika Kedra	Benthic	U.Maryland	VIC	Bar
Lisa Wilt	Benthic	U.Maryland	VIC	Bar
Dominic DiMaggio	Benthic/UCTD	US Navy	VIC	Bar
Shigei Nishino	JAMSTEC mooring deployments in Chukchi Sea and Barrow Canyon	JAMSTEC	VIC	Bar
Hirokatsu Uno	JAMSTEC mooring deployments in Chukchi Sea and Barrow Canyon	JAMSTEC	VIC	Bar

SUMMARY of RESULTS:

During the stops at 26 science stations, the following science tasks were completed

- 26 CTD/Rosette casts,
- 25 150 kHz ADCP deployments,
- 19 Bongo plankton net hauls,
- 23 Benthic sampling stations with between 1 and 5 grabs at each station.
- At some of the stations water from a range of depths was collected for incubation experiments taking place in a tank on the helicopter deck.

Underway data collection included:

- obtaining 37 CTD profiles at regular cruising speed every six (and sometimes every three) hours using an underway CTD (UCTD) system deployed from the stern of the ship (Figure 1). Across the pacific the probe was dropped to approximately 400 m. An additional 9 profiles to the depth of water were collected after passing through Unimak Pass and all the way to the first science station. In

addition, daily Expendable CTD probes (XCTD) were deployed from the ship to 1000 m across the NE Pacific. During these drops the ship slowed to 8 knots for a few minutes.

- continuous monitoring of surface water properties with electronic sensors from the seawater loop in the main lab on board (temperature, salinity, chlorophyll, oxygen and nitrogen),
- bird and mammal observations during daylight hours (bird observations continued to Kugluktuk),
- and meteorological data from ship sensors.

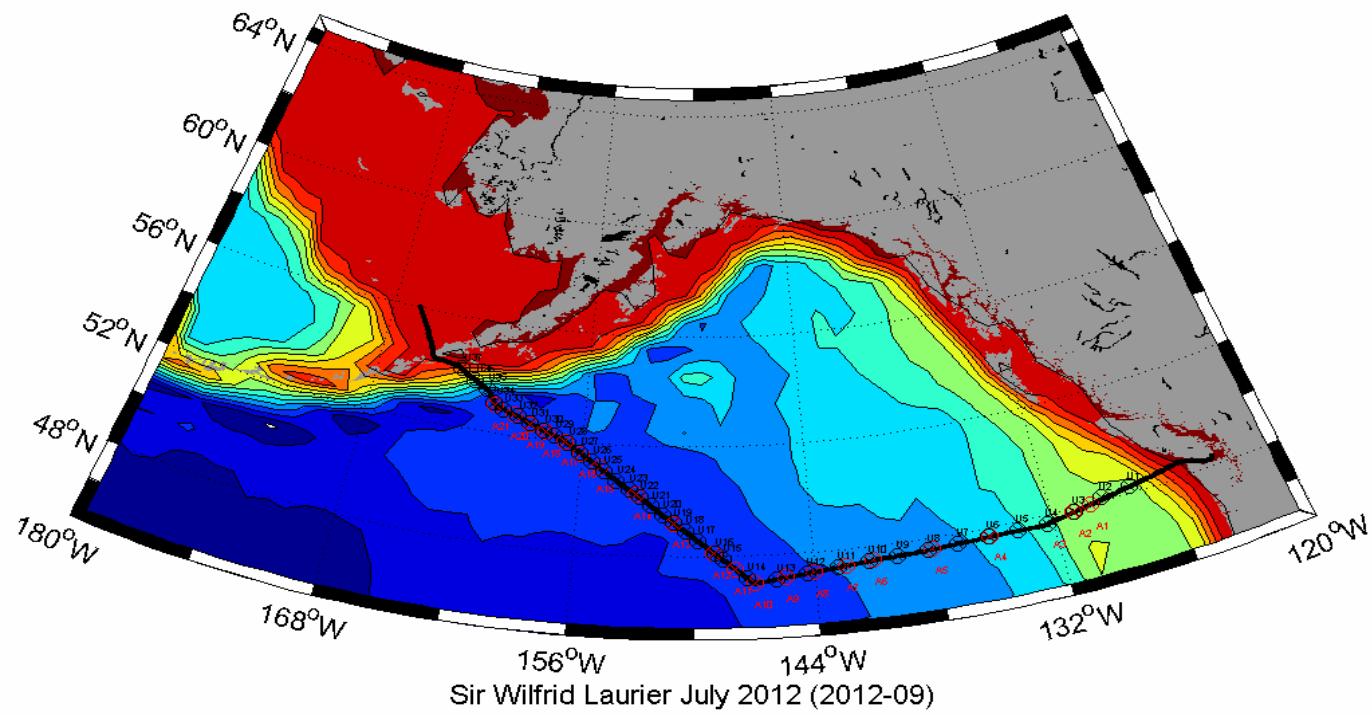

Figure 1. Ship track across the NE Pacific with the locations of UCTD profiles (Black circles with black crosses) and Argo float deployments positions (Red circles with red crosses).

Argo float deployments:

During the transect across the NE Pacific we deployed two groups of Argo floats, the larger group of 13 floats originating from Howard Freeland at IOS/DFO and the smaller group of 8 floats originating from Elizabeth Steffen at PMEL in Seattle. The Freeland floats are NOVA floats made by the MetOcean Corporation (Middle photo in Figure 2) and the 8 Steffen floats are NAVIS floats made by SeaBird (Right photo in Figure 2). All floats were successfully launched using a specially made sling, that originated from Howard Freeland, but who was upgraded by SWL crew to make it stronger. After the ship had slowed down to about 2 knots on station, the sling with a float was swung over the side and the float was lowered to about 1 m above the highest wave before a release hook was let go and the float was deployed. The deployment locations of the 21 floats are shown in Figure 1.

Figure 2. (Left) Argo float ready for deployment in handy sling that was lowered to about 1 m above the highest waves before a float was released.

Biogeochemical JAMSTEC mooring deployments:

Two scientists from JAMSTEC in Japan was onboard from Victoria to deploy four moorings, two in the Southern Chukchi Sea and two in Barrow Canyon (Figure 3). The two moorings along the DBO line in the southern Chukchi Sea were deployed on 16 July near station UTN-5 (SEC-1). The locations of the moorings were: SCH-12W: 67N43.0922 168W50.0096 in water depth of 52 m and SCH-12 : 67N42.1829 168W50.0161 in water depth of 52 m. Both these moorings were scheduled to be recovered and redeployed by Mirai in the autumn of 2012. The former mooring (SCH-12W) has a whale recorder and the second mooring (SCH-12) measures the physical and biological environments (i.e. temperature, salinity, oxygen, Chl-a, and zooplankton concentrations). The other two moorings (Figure 3 A and B) were deployed in Barrow Canyon after July 22 (after the rest of the science team had departed).

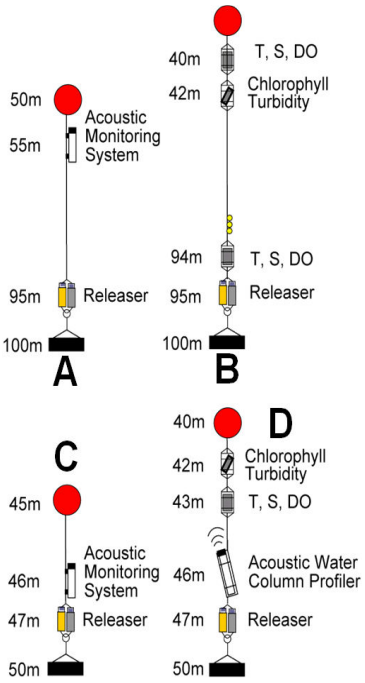

Figure 3. JAMSTEC moorings deployed in southern Chukchi Sea (C and D) and in Barrow Canyon (A and B). Right photo shows Hirokatsu testing the acoustic communication with one of the moorings before deployment.

Surface velocity profilers (SVP):

The two JAMSTEC scientists also deployed four SVPs (Figure 4); two on 14 July near the first science station (SLIP-1) at 62N0.73 175W 3.98 and two on 16 July near the first Southern Chukchi DBO station (SEC-2) at 67N46.8 168W36.4.

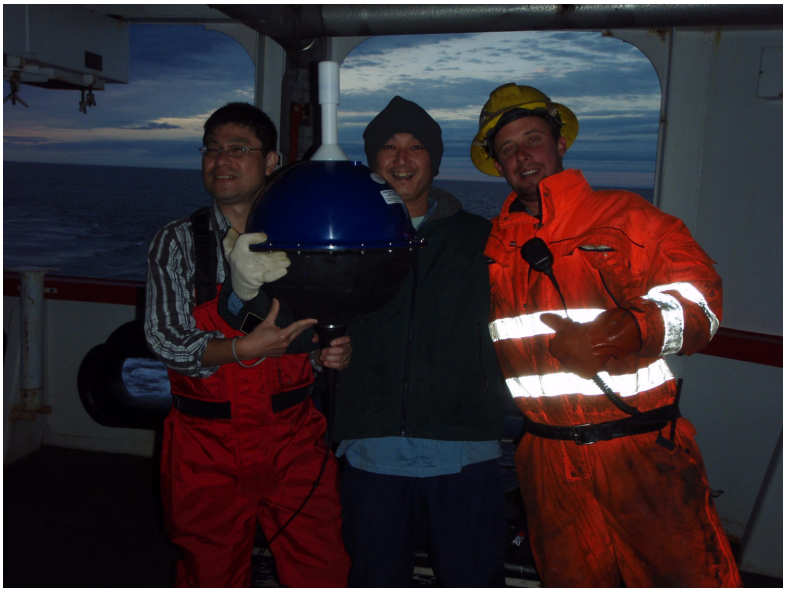

Figure 4. Surface velocity profiler (SVP) ready for deployment.

AREAS OF OPERATION:

North Pacific, Bering Sea, Chukchi Sea (Figure 5).

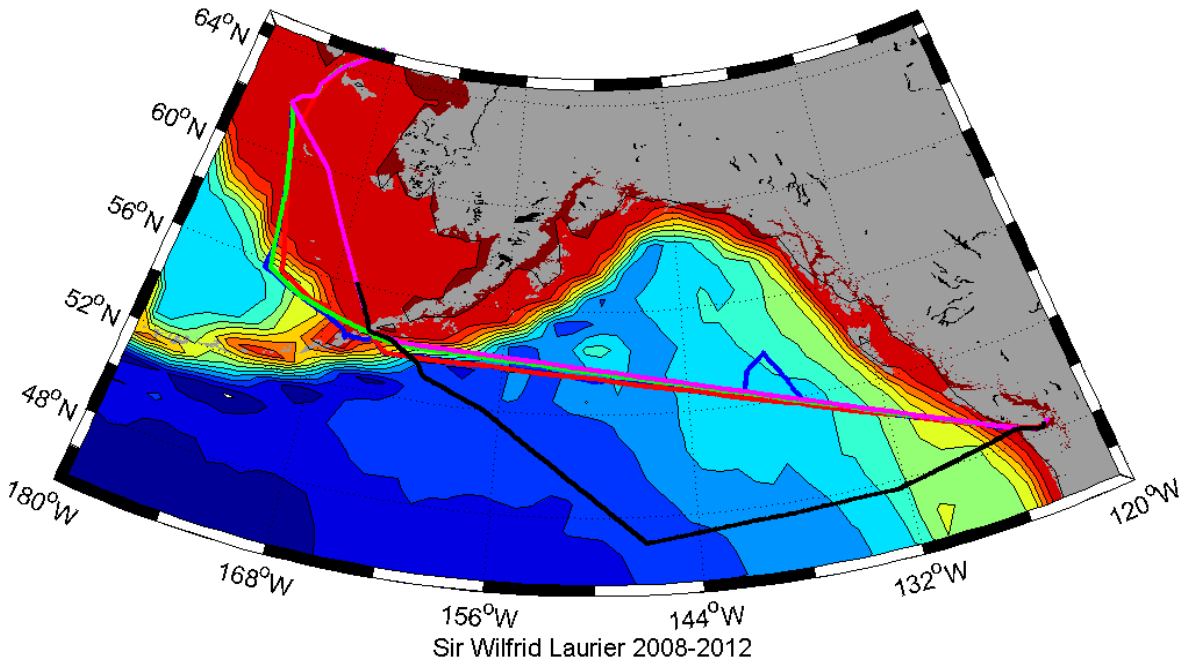

Figure 5. SWL Ship tracks for the last five years. The black line shows the 2012 track and how it departed from previous years. From Unimak Pass and northwards the 2012 track follows the 2011 track (pink line).

FIELDWORK:

Science activities aboard the CCGS Sir Wilfrid Laurier for the July leg of the program covered two distinct segments:

1. Across the North Pacific from Victoria, BC to Bering Shelf:
   - Continuous measurements of near-surface water properties from the salt-water loop in the main laboratory.
   - Underway CTD-probe deployed to a depth of 400 m behind the ship every 6 hours or sometimes 3 hours, without any interruption to ship speed and routines (Figure 6). Daily XCTDs to 1000 m were added to extend the depth of the observations to 1000 m. A summary of the temperature data obtained from both UCTD and XCTD casts are shown in Figure 7.
2. During the Bering/Chukchi Seas segment from the Aleutian Islands to Barrow, Alaska, a number of repeat benthic stations were occupied as outlined in the table in the appendix (Figure 8). At these benthic locations:
   - Rosette casts were done to get samples from the overlying water column for the biology and geochemistry groups;
   - A Bongo plankton net haul was done at most stations,
   - ADCP acoustic data on currents and acoustic backscatter were collected at all stations except one. (Figure 9).
   - Primary productivity incubation experiments where conducted using water from a subgroup of stations (Figure 10).
   - During the trip we had 5 drops with a total of 98 drift bottles, as part of the ongoing driftbottle experiment at IOS (Figure 11).

Figure 6. Underway CTD system mounted at the stern of the ship. During the trip profiles were obtained at least every 6 hours across the NE Pacific to a maximum depth of 400 m. A total of 46 profiles were collected during the cruise.

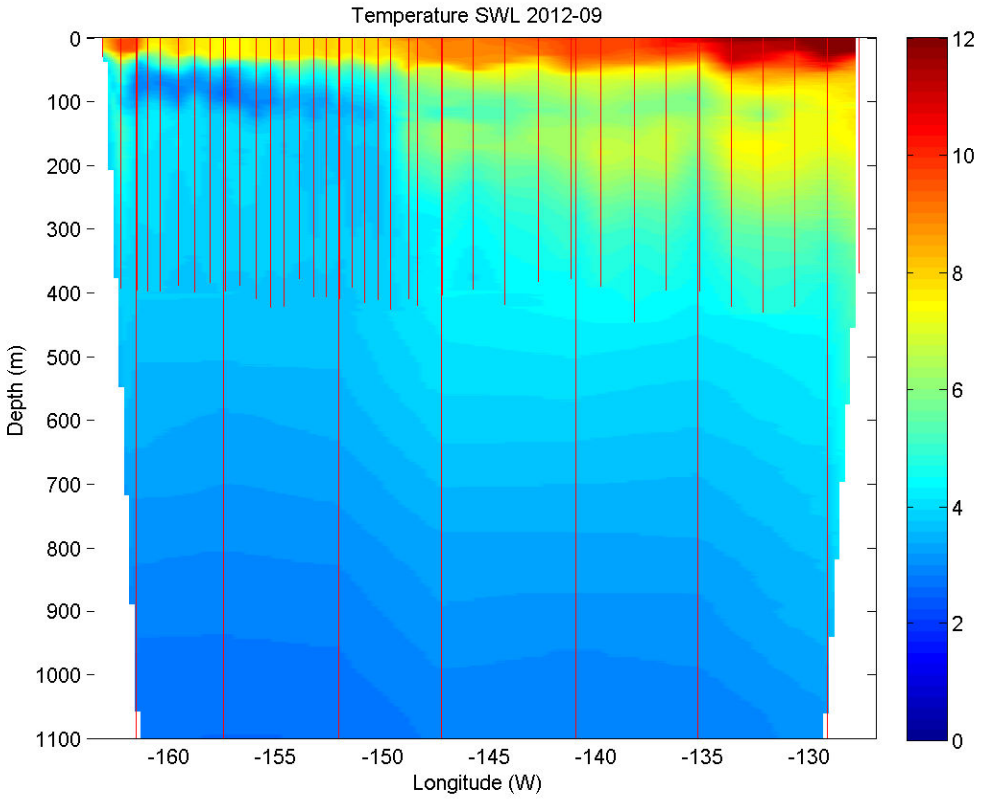

Figure 7. Temperature field across the NE Pacific from UCTD and XCTD profiles. The red vertical lines show the exact locations and the depths of each cast.

Figure 8. Benthic sampling in Bering and Chukchi Sea by Jackie Grebmeier's group from the University of Maryland.

Figure 9. The 150 kHz Acoustic Doppler Current Profiler (ADCP) in its stainless steel frame on deck just prior to deployment.

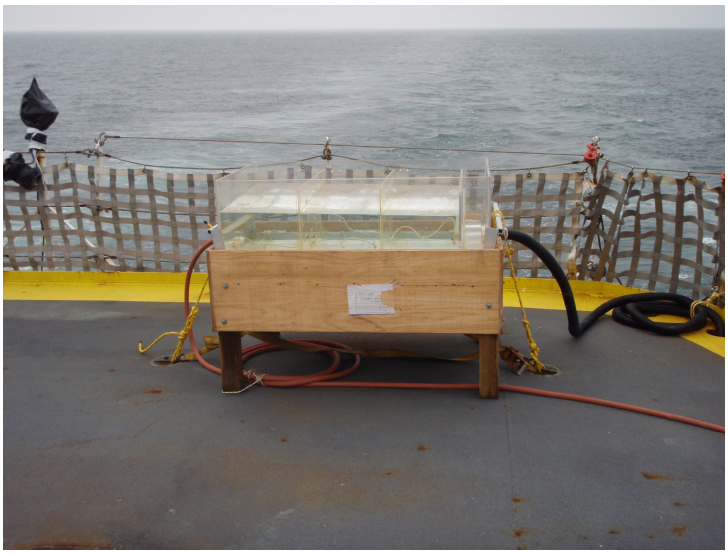

Figure 10. Phyto-plankton incubators on the helicopter deck. These were operated by Rhiannonl Pretty from Professor Diana Varela's laboratory at UVIC.

Figure 11. Drift bottles beeing readied for deployment by a joint science and ship's crew team.

Shipboard labs

Laboratory spaces on board were used to collect samples for nutrients and salts and electronic sensor data from the seawater loop and to filter rosette samples for chlorophyll (Forward main lab.). Zooplankton samples from Bongo casts where prepared and stored for subsequent analysis back at IOS in the green container on the main deck. The aft laboratory was used to prepare sample bottles prior to sampling the rosette/CTD and to run the ADCP and updated documentation. Benthic and phytoplankton analysis were done in the main laboratory.

Deck space was used by science for launch and retrieval of equipment and instrumentation, including CTD/rosette for profiling & water sampling and for the launching and recovery of the underway CTD (UCTD) and XCTD systems. The breezeway on the port side of the ship was used to store, deploy and recover the 150 kHz ADCP package for acoustic current and zooplankton measurements. The zooplankton Bongo nets and the Van veen grabs were deployed and recovered using the A-frame on the starboard side of the well deck.

To facilitate the science, two container labs were installed, but during this leg only the 20-ft green container was used for science operations. It was used for sample preparations following Bongo net hauls and for storage of equipment used for benthic sampling.
The 20-ft aluminium container on the boat deck provided much needed storage space, especially for UCTD boxes and spare parts and for phytoplankton sampling equipment.
The container labs are well suited for lab duties, outfitted with counter space, shelving, simple sink, heat and power for instruments. Both are hooked up to electrical power for lights and heat, and had phone, ship's intercom and network connections. During the trip the forward container was also equipped with real-time display of the 12 kHz sonar in the aft lab, even though on this leg, this system was not used.

SUCCESSES AND PROBLEMS [SCIENTIFIC]:

All of the science instrumentation provided scientifically valuable data, and will help to combine biological findings with measurements of the physical characteristics of the ocean. All the scientific equipment performed well throughout the trip. The data collected will be used with data collected along the same ship track and at similar stations in earlier years to investigate interactions between the biological conditions and the physical parameters that govern their environment and to allow for studies of possible ecosystem changes due to climate change.

CTD/rosette system

A Seabird SBE-9 profiling CTD was used with a custom built compact 24-bottle rosette water sampler. The CTD was equipped with the standard suite of pressure, temperature and conductivity sensors, and additional external sensors: a fluorometer to measure chlorophyll-a concentrations, a transmissometer to measure water clarity, a dissolved oxygen probe, and an acoustic altimeter to get accurate height above the bottom.

The 24-bottle rosette system (Figure 12) was equipped with a Seabird Carousel pylon to remotely trigger the 10-litre sample bottles. An SBE-11 deck unit was used with Seasave software to acquire real-time data from the CTD and to close the bottles at depths selected before and/or during the cast. The deck unit included a NMEA board to automatically add GPS position into the header of the data file. This system worked very well during the trip.

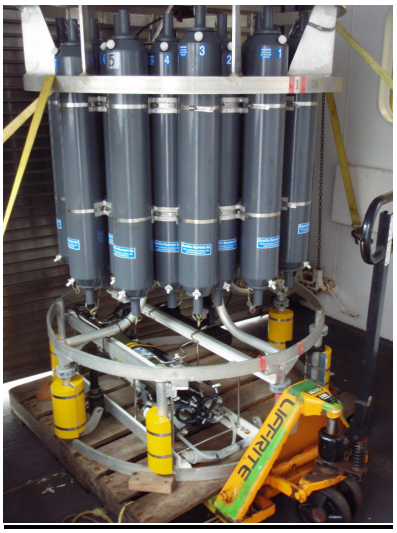

Figure 12. The 24 Nisken-bottles rosette system successfully used during the trip to collect water at selected depths.

Plankton nets

Single Bongo plankton net hauls to a depth of water-depth minus 10 m were done at most stations, using the hydro winch and A-frame on the well-deck. These casts were done right after the CTD/rosette casts while water was being sampled from the rosette Nisken bottles.

ADCP/Backscatter sonar

A 150 kHz Teledyne RDI Acoustic Doppler Current Profiler (ADCP) was mounted in a stainless steel frame and lowered over the side when stopped at each science station (Figure 9). This package was the first to be deployed at each science station and the last to be recovered.
Data from this instrument gives current profiles below the ship to a depth of 500 m and a measure of plankton layers in the water column down to approximately 200 m.

Drift bottles

As part of a project started in 2000, 98 drift bottles, each containing a message with serial number and reporting contact information, were launched at five selected locations along the ship's track (Figure 11). The drop locations are logged, and when finds are reported this provides information on ocean surface drift trajectories. A website is maintained at IOS to document all drops and finds, and map the results.

Underway CTD system

During this cruise an underway CTD system was successfully used to collect temperature and conductivity (salinity) data from the surface and down to a maximum depth of 400 m while the ship was moving at cruising speed (Figure 6). In waters with depths greater than 500 m the probe was dropped to 400 m. Across the Pacific the probe was deployed at least every 6 hours and the complete operation took less than 20 minutes per cast. This is the second year that this instrumentation has been used successfully. This is an excellent method to collect high quality CTD data from the ship without interfering with speed and ship operations.

PROBLEMS [SHIP'S EQUIPMENT/OPERATIONS/PLATFORM SUITABILITY]:

The SWL is very well suited for this type of ship based oceanography. No problems were reported during the cruise. A major reason for yet another successful mission is the wonderful support from and professionalism of the ship's officers and crew.

SUCCESSES [SHIP]:

The support of officers and crew in getting our equipment onboard, up and running, and during all station operations and data collection is invaluable and greatly appreciated. The science party had a wonderful time onboard the ship.

DAYS LOST DUE TO WEATHER OR ICE:

No science lost due to weather. The weather across the NE Pacific and through the Bering Sea and into the Chukchi Sea was exceptional, with very little wind and a number of clear, sunny days.
However, even as the ship left Victoria the ice charts showed ice off Barrow and covering Barrow Canyon where 10 of our stations are located (Figure 13). Throughout the whole trip north we were hoping that the ice would move away from the area, but this did not happen until after the main science party had to disembark the ship. We were therefore not able to finish the last 10 science stations which is part of the DBO line across Barrow Canyon.

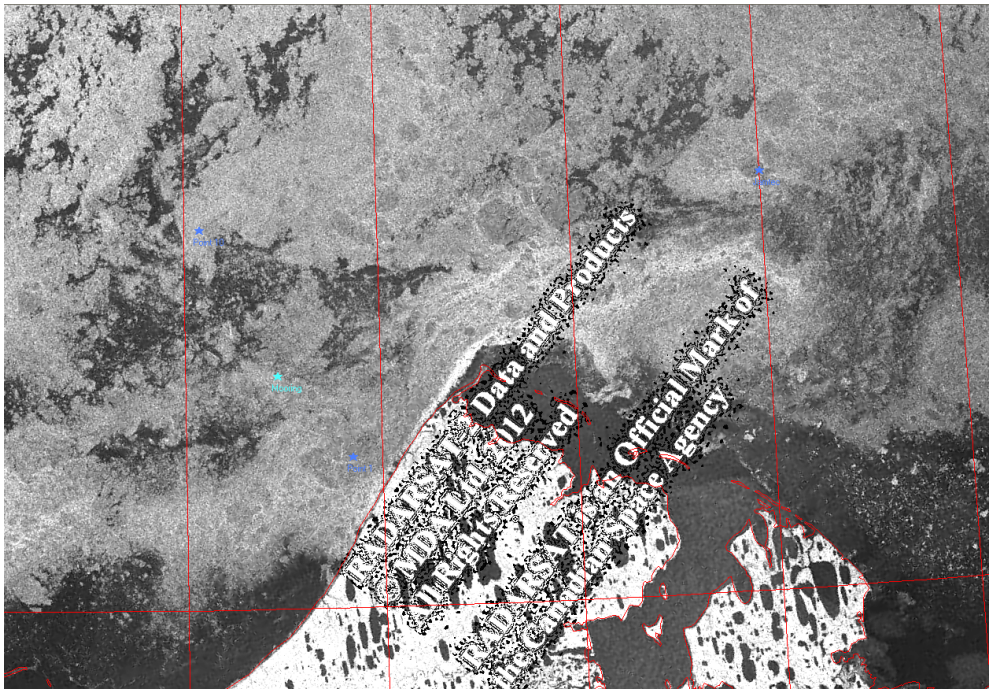

Figure 13. Ice off Barrow, blocking our access to the DBO stations across Barrow Canyon

DELAYS [OTHER THAN WEATHER]:

No delays. The ship was actually going nearly to fast through the Bering Sea, resulting in science stations nearly coming to fast for the science team to keep up. It seems like there was a strong northward current moving hte ship northward with considerable speed. At the end the ship had to sit at the ice edge an wait for changes to wind and ice conditions to proceed towards Barrow. Most of the science team had to be air-lifted to Barrow on 21 July to be able to make the flights south on 22 July.

SAFETY CONCERNS:

No safety concerns were reported.

SUMMARY/FINAL COMMENTS:

Again we want to express our gratitude for all the invaluable support we received from Captain Stuart Aldridge and his officers and crew on the Sir Wilfrid Laurier. A major reason for the success of the science component of this trip is all the help we received from the ship's crew. The wonderful crossing ceremony and other social interactions also made it a fun and memorable experience for all of the science team onboard.

for additional information on this report contact
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Appendix Science Stations

-ADCP is the down-looking 150 kHz Acoustic Doppler Current Profiler,
-CTDR is the CTD/Rosette electronic profiling and water sampling instrumentation deployed to the seafloor minus 5 m at each science station,
-Mud indicates collection of bottom samples by the University of Maryland team.
-Bongo is the dual plankton net vertical haul from depths of 100 m or less at the shallower stations. In addition, an underway salinity, temperature, depth (UCTD) probe was deployed at least every six hours while underway between Victoria and the Aleutian Islands.

Station Name	Date	Start (UTC)	Lat. North (deg)	Lat (min)	Long. West (deg)	Long (min)	Science Tasks
Victoria	7/4/2012	21:00	48	25.215	123	23.343	Depart for Arctic
SLIP-1	07/14	08:02	62	0.589	175	3.604	ADCP, CTDR, Bongo, Mud
SLIP-2	07/14	10:18	62	2.994	175	12.596	ADCP, CTDR, Mud
SLIP-3	07/14	13:57	62	23.402	174	34.217	ADCP, CTDR, Bongo, Mud
SLIP-5	07/14	18:06	62	33.604	173	33.076	ADCP, CTDR, Mud
SLIP-4	07/14	21:46	63	1.798	173	27.604	ADCP, CTDR, Bongo, Mud
BCL-6A	07/15	05:12	63	55.199	172	5.893	ADCP, CTDR,
UTBS-5	07/15	11:49	64	40.19	169	55.217	ADCP, CTDR, Bongo, Mud
UTBS-1	07/15	14:49	64	59.423	169	8.333	ADCP, CTDR, Bongo, Mud
UTBS-2	07/15	17:32	64	40.813	169	5.992	ADCP, CTDR, Bongo, Mud
UTBS-4	07/15	20:26	64	57.598	169	53.362	ADCP, CTDR, Mud
BRS-3	07/16	02:16	65	42.004	168	46.729	ADCP, CTDR, Bongo
UTN-1	07/16	07:55	66	42.6	168	24	ADCP, CTDR, Bongo, Mud
UTN-2	07/16	10:57	67	3.014	168	43.709	ADCP, CTDR, Mud
UTN-3	07/16	13:39	67	19.788	168	54.522	ADCP, CTDR, Mud
UTN-4	07/16	15:21	67	29.984	168	54.503	ADCP, CTDR, Bongo, Mud
UTN-5	07/16	17:24	67	40.184	168	54.576	ADCP, CTDR, Bongo, Mud
UTN-6	07/16	20:41	67	44.404	168	26.422	ADCP, CTDR, Bongo, Mud
SEC-2	07/16	22:12	67	46.784	168	35.97	ADCP, CTDR, Bongo, Mud
UTN-7	07/17	00:49	68	0.004	168	54.593	ADCP, CTDR, Bongo, Mud
SEC-3	07/17	03:29	67	54.01	168	14.413	ADCP, CTDR, Bongo, Mud
SEC-4	07/17	05:30	68	0.601	167	52.24	ADCP, CTDR, Bongo, Mud
SEC-5	07/17	07:27	68	7.8	167	30.114	ADCP, CTDR, Bongo, Mud
SEC-6	07/17	09:25	68	11.407	167	18.673	ADCP, CTDR, Bongo, Mud
SEC-7	07/17	10:23	68	14.402	167	7.285	ADCP, CTDR, Bongo, Mud
SEC-8	07/17	11:38	68	18.031	166	56.501	ADCP, CTDR, Bongo, Mud
CS-2011	07/18	20:44	69	48.607	163	25.777	CTDR, Bongo
Barrow	7/21/2010						Science program ends